

DOT/FAA/CT-TN03/9

PORTLAND INTERNATIONAL AIRPORT

Summary of Tactical Initiatives

Airport Capacity Design Team



March 2003

**Prepared by
Federal Aviation Administration
FAA William J. Hughes Technical Center
Atlantic City International Airport, New Jersey**

Technical Report Documentation Page

1. Report No. DOT/FAA/CT-TN03/9	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Portland International Airport Summary of Tactical Initiatives Airport Capacity Design Team		5. Report Date March 2003	
		6. Performing Organization Code ACB-320	
7. Author(s) Helen Monk and Cassandra Miller Modeling & Analysis Group, ACB-320		8. Performing Organization Report No.	
9. Performing Organization Name and Address FAA William J. Hughes Technical Center Modeling & Analysis Group, ACB-320 Atlantic City International Airport, NJ 08405		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No.	
12. Sponsoring Agency Name and Address		13. Type of Report and Period Covered Summary Report	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract This report summarizes the results of the tactical initiatives studied by the Portland International Airport Design Team.			
17. Key Words Airport Capacity/Delay Simulation Tactical Initiatives Portland International Airport		18. Distribution Statement Document is on file at the FAA William J. Hughes Technical Center Library Atlantic City International Airport, NJ 08405	
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages 21	22. Price

Portland International Airport (PDX)

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1. INTRODUCTION

Background

The Portland International Airport (PDX) Capacity Enhancement Plan Update was completed in 2001. This Design Team provided an updated capacity study to assess the technical merits of potential airfield expansion as presented in the Portland Master Plan update of September 2000.

The Design Team met in April 2002 and developed a list of Tactical Initiatives, which it wanted evaluated. The FAA Technical Center performed the Tactical Initiatives and presented the results to the group at the January 2003 kickoff meeting of the Phase II Capacity Enhancement Design Team. The group accepted the results and asked the Technical Center to publish a summary report.

List of Tactical Initiatives

- *Third Parallel Runway and N/S Taxiway, With Existing Departure Noise Restrictions*
- *N/S Taxiway and Existing Departure Noise Restrictions*
- *Extend Runway 10L/28R 1,500 feet to the West*
- *Add Exit A-1A to Runway 10L, between Exits A-2 and A-1 (and 1,000' West of A-1)*
- *Add Exits on Taxiway C – Exits C-2, C-4, and C-5*

Annual and Daily Demand

The Design Team simulated 3 demand levels in the 2001 Capacity Plan Update. The schedule for the 1999 demand level was developed from Tower counts and OAG data for Tuesday, July 27, 1999, and cargo schedules for August 2000.

<u>Demand Level</u>	<u>Annual Operations</u>	<u>Daily Operations</u>	<u>Equivalent Days</u>
1999(Baseline)	322,000	1,006	320
Future 1	484,000	1,512	320
Future 2	620,000	1,938	320

Note: (Annual Operations) / (Daily Operations) = Equivalent Days

Fleet Mix By Aircraft Classifications

H Heavy	757	LJ Large Jet	LTP Large Turboprop	S+ Small+	S Small	Total	
4.7%	5.2%	46.3%	17.6%	14.7%	11.5%	100.0%	1999 (Baseline)
4.9%	5.3%	47.6%	18.1%	14.0%	10.1%	100.0%	Future 1
5.0%	5.5%	48.5%	18.6%	13.5%	9.0%	100.0%	Future 2

Notes: Percentages are rounded to 1 decimal place.

Aircraft Classifications used were based on 1999 FAA separation standards.

Annual Delay Costs and Fleet Mix Cost

The annual delay costs are based on the PDX Fleet Mix Cost of \$ 1,660 per hour used in the 2001 Capacity Enhancement Plan. The Fleet Mix Cost reflects the direct operating costs for the air carriers and non-scheduled aircraft operating at PDX.

2. RESULTS OF TACTICAL INITIATIVES

The results of the following tactical initiatives are summarized in this report:

- *Third Parallel Runway and N/S Taxiway, With Existing Departure Noise Restrictions*
- *N/S Taxiway and Existing Departure Noise Restrictions*
- *Extend Runway 10L/28R 1,500 feet to the West*
- *Add Exit A-1A to Runway 10L, between Exits A-2 and A-1 (and 1,000' West of A-1)*
- *Add Exits on Taxiway C – Exits C-2, C-4, and C-5*

THIRD PARALLEL RUNWAY AND N/S TAXIWAY, WITH EXISTING DEPARTURE NOISE RESTRICTIONS

The Port of Portland wanted to compare the delays associated with constructing a third parallel runway, with the existing departure noise restrictions, against the delays associated with removing the departure noise restrictions for Turboprops and Biz Jets.

Exhibit 1 shows the average annual delay per operation and the annual delay costs in year 2000 dollars for the *Third Parallel Runway and N/S Taxiway, With Existing Departure Noise Restrictions*.

The Technical Center simulated this improvement for the Future 1 and 2 demand levels.

The results of this analysis show that the delays for these two improvements would be the same:

- *Third Parallel Runway and N/S Taxiway, with Existing Departure Noise Restrictions (Improvement 1, 3)*
- *No Departure Noise Restrictions for Turboprops and Biz Jets (Improvement 5)*

The average annual delay per operation would be:

- **4.3 minutes at Future 1 (484,000 annual operations)**
- **17.9 minutes at Future 2 (620,000 annual operations)**

The improvement numbers (1, 3) and (5) were the improvement numbers used in the 2001 PDX Capacity Enhancement Plan.

N/S TAXIWAY AND EXISTING DEPARTURE NOISE RESTRICTIONS

Exhibit 2 shows the average annual delay per operation and the annual delay costs (in hours and year 2000 dollars) for the *N/S Taxiway & Existing Departure Noise Restrictions – with Staggered Approaches in IFR1 and Independent Approaches in IFR1*.

The Technical Center simulated these improvements for the Future 1 and 2 demand levels.

The **average annual delay per operation** with Staggered Approaches in IFR1, PKG (C1), would be:

- 5.8 minutes at Future 1 (484,000 annual operations)
- 35.5 minutes at Future 2 (620,000 annual operations)

When compared to the Do-Nothing case, this improvement (with staggered approaches in IFR1) could reduce annual delay by 9% at Future 1 and 16% at Future 2.

The **average annual delay per operation** with Independent Approaches in IFR1, PKG (C2), would be:

- 5.4 minutes at Future 1 (484,000 annual operations)
- 34.3 minutes at Future 2 (620,000 annual operations)

When compared to the Do-Nothing case, this improvement (with independent approaches in IFR1) could reduce annual delay by 16% at Future 1 and 19% at Future 2.

The improvements (C1) and (C2) refer to simulation scenarios PKG (C1) and PKG (C2) in the 2001 PDX Summary Data Package.

EXTEND RUNWAY 10L/28R 1,500 FEET TO THE WEST

Exhibit 3 shows the average annual taxi time savings (in hours and year 2000 dollars) for the improvement *Extend 10L/28R 1,500 feet to the West*.

The Tech Center simulated this improvement for the 1999 and Future 1 demand levels. The simulations assumed Heavy International aircraft would arrive and depart on the North Runway in both the East and West Flow simulations. The delays were virtually the same as the Basecase, in which the aircraft used the South Runway because it needed the extra length. The improvement did not reduce delays. This was expected because so few aircraft were affected and the departure noise restrictions were still in place.

The benefit of the runway extension was the reduced taxi time for departures in the East Flow. Aircraft taxiing to the new 10L threshold instead of the 10R threshold would have a shorter taxi distance (approximately 3,900 feet shorter) and a shorter taxi time. An aircraft taxiing at 15 miles per hour (MPH) would save 2.95 minutes.

The Tech Center performed a sensitivity analysis on the number of International Heavy Departures per Day -- from 10 to 40 daily departures. The savings estimates are based on the numbers of daily operations -- not on a demand level. The Design Team had 10 International Heavy Departures per day at the 1999 demand, 15 at Future 1, and 18 at Future 2. Taxi speeds for a Heavy would be approximately 15 MPH (13 knots).

With taxi speeds of 15 MPH providing a reasonable savings estimate, the extension could save the following:

- **82 hours and \$136,000 at the 1999 demand,**
- **123 hours and \$204,000 at Future 1, and**
- **148 hours and \$246,000 at Future 2.**

ADD EXIT A-1A TO RUNWAY 10L, BETWEEN EXITS A-2 AND A-1 (AND 1,000' WEST OF A-1)

Exhibit 4 provides the annual taxi and occupancy time savings (in hours and year 2000 dollars) for *Add Exit A-1A between Exits A-2 and A-1 (and 1,000' West of A-1)* as follows:

- Combined annual taxi and occupancy time savings,
- Annual taxi time savings,
- Annual occupancy time savings.

The Tech Center simulated this improvement for the 1999 and Future 1 demand levels. The simulations assumed Heavies, 757s, and Large arrivals on 10L could reduce their runway occupancy times by 7 seconds by using exit A-1A instead of A-1. The delays were virtually the same as the Basecase. The improvement did not reduce delays. This was expected because the improvement would not reduce arrival separations – the spacing between successive arrivals on final. The reduced occupancy time could allow a trailing departure to be released 7 seconds sooner if there was a departure available to be released. Since departure noise restrictions still apply, there could be little or no effect on departures.

Because the simulations did not show a delay reduction, the Tech Center used an analytical approach to determine the benefit to arrivals in terms of reduced runway occupancy times and reduced taxi times. The analysis assumed Heavies, 757s, and Large arrivals on 10L could reduce their runway occupancy times by 7 seconds by using exit A-1A instead of A-1. Those aircraft would also reduce their taxi times because their taxi distance would be reduced by 1,000'. An aircraft taxiing at 15 miles per hour (MPH) would save 0.76 minutes.

The Tech Center performed a sensitivity analysis on the number of arrivals that could benefit from the new exit – from 19 to 100 arrivals per day. The savings estimates are based on the numbers of daily operations -- not on a demand level. The Design Team had 19 arrivals per day at the 1999 demand, 36 at Future 1, and 51 at Future 2.

With taxi speeds of 15 MPH (13 knots) providing a reasonable savings estimate, Exit A-1A could save the following:

- 46 hours and \$76,000 at the 1999 demand,
- 88 hours and \$146,000 at Future 1, and
- 125 hours and \$208,000 at Future 2.

ADD EXITS ON TAXIWAY C – EXITS C-2, C-4, AND C-5

Exhibit 5 provides the annual savings for adding Exits C-2, C-4, and C-5 as follows:

- Exit C-2 East Flow – combined travel and occupancy time savings,
- Exit C-2 West Flow – runway crossing time savings,
- Exit C-4 – combined travel and occupancy time savings, and
- Exit C-5 – combined travel and occupancy time savings.

The Tech Center used an analytical approach to determine the benefit of adding exits on Taxiway C.

Exit C-2 provides dollar savings in both flow directions and reduces the number of runway crossings in the West Flow. The benefits are the following:

In the East Flow, with taxi speeds of 15 MPH (13 knots), Exit C-2 could save the following:

- 10 hours and \$16,600 at the 1999 demand,
- 15 hours and \$24,900 at Future 1.

In the West Flow, Exit C-2 could save the following:

- 2,748 runway crossings, 23 hours, and \$38,000 at the 1999 demand,
- 3,358 runway crossings, 28 hours, and \$46,000 at Future 1.

With taxi speeds of 15 MPH (13 knots), Exit C-4 could save the following:

- 11 hours and \$18,300 at the 1999 demand,
- 19 hours and \$31,500 at Future 1.

With taxi speeds of 15 MPH (13 knots), Exit C-5 could save the following:

- 64 hours and \$106,000 at the 1999 demand,
- 79 hours and \$131,000 at Future 1.

EXHIBIT 1 – NEW PARALLEL RUNWAY WITH EXISTING DEPARTURE NOISE RESTRICTIONS
(with N/S Taxiway)

PDX AVERAGE ANNUAL DELAY PER OPERATION (in minutes) -- TABLE

IMPROVEMENT STUDIED		322,000 (1999) Minutes	484,000 (F1) Minutes	620,000 (F2) Minutes
A	Basecase With Existing Departure Noise Restrictions	1.4	6.4	42.1
B	5. No Departure Noise Restrictions for Turboprops and Biz Jets	1.1	4.3	17.9
X	1, 3 Third Parallel Runway and N/S Taxiway, With Existing Departure Noise Restrictions	-----	4.3	17.9
C	6. No Departure Noise Restrictions for Any Aircraft	1.1	3.9	14.7
D	3, 6 N/S Taxiway and No Departure Noise Restrictions for Any Aircraft	-----	3.0	9.3
E	4, 3, 6 Simultaneous CAT I Approaches to Existing Parallels, N/S Taxiway, and No Departure Noise Restrictions for Any Aircraft	-----	2.6	7.3
F	1, 3, 6 Third Parallel Runway, N/S Taxiway, and No Departure Noise Restrictions for Any Aircraft	-----	1.9	4.5

PDX ANNUAL DELAY COSTS (in millions of dollars) – GRAPH

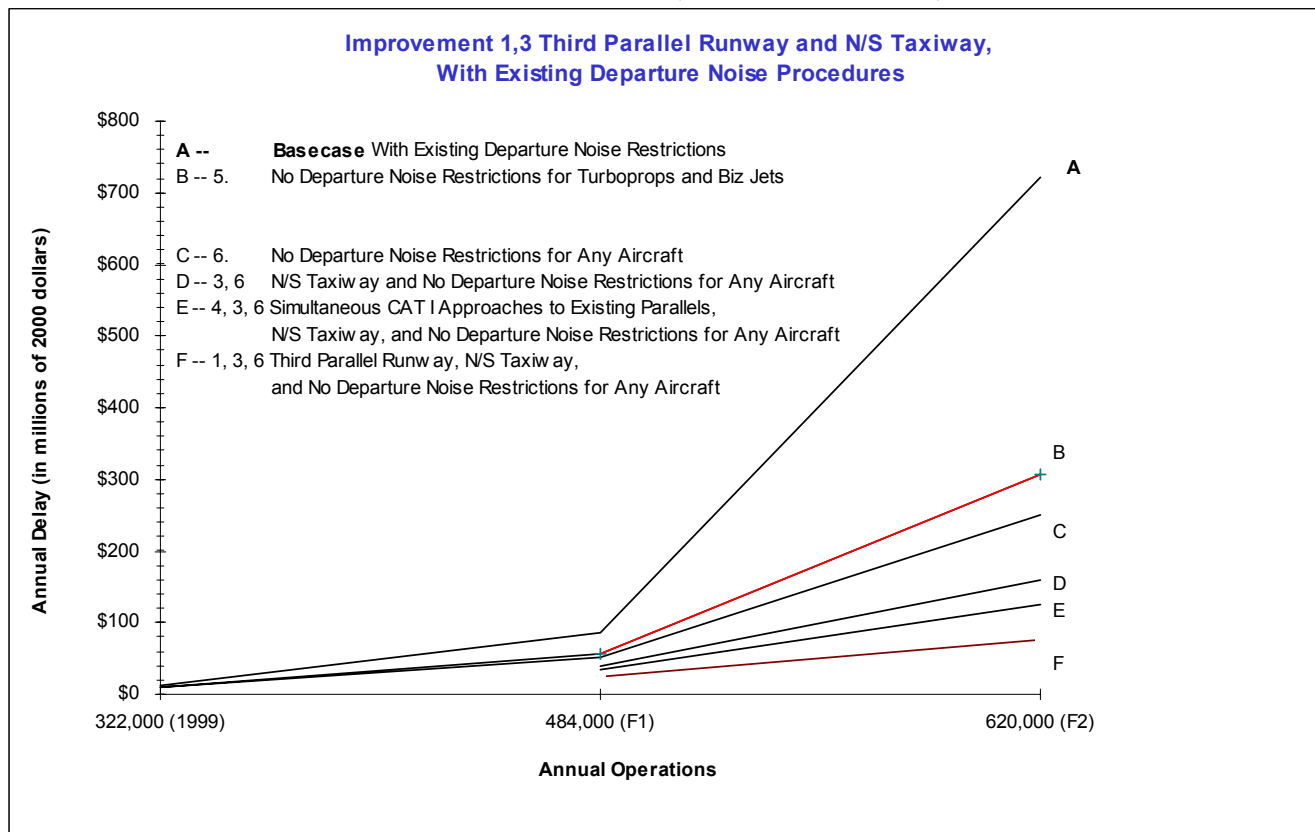


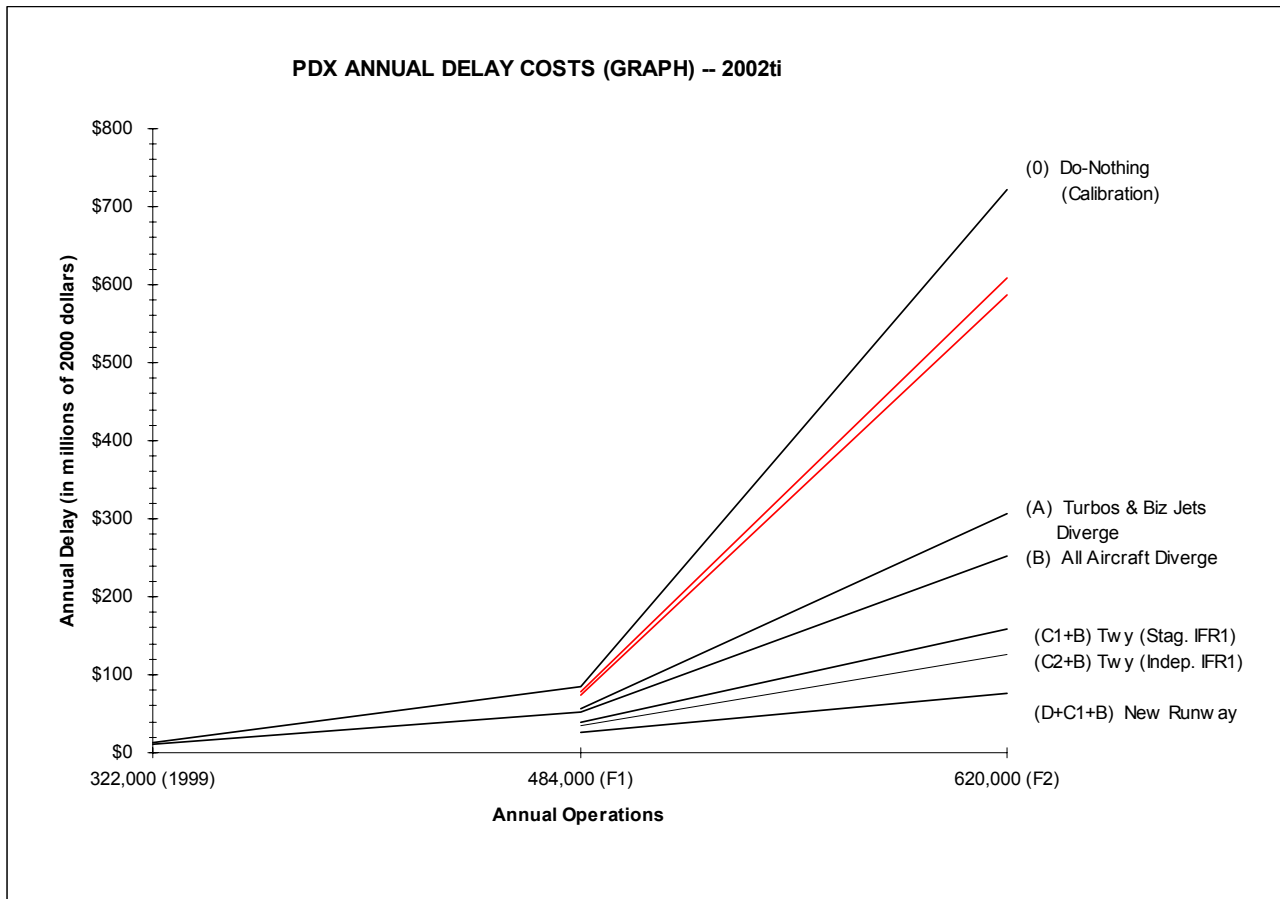
EXHIBIT 2 – N/S TAXIWAY AND EXISTING DEPARTURE NOISE RESTRICTIONS

PDX AVERAGE ANNUAL DELAY PER OPERATION (in minutes) – TABLE

IMPROVEMENT STUDIED	322,000 (1999) Minutes	484,000 (F1) Minutes	620,000 (F2) Minutes
(0) CALIBRATION (Do-Nothing)	1.4	6.4	42.1
(C1) N/S Twy & Noise (Stag. IFR1 Approaches)	-----	5.8	35.5
(C2) N/S Twy & Noise (Indep. IFR1 Approaches)	-----	5.4	34.3
(A) All Turbos & Biz Jets Can Diverge	1.1	4.3	17.9
(B) All Aircraft Can Diverge	1.1	3.9	14.7
(C1+B) N/S Taxiway (Stag. IFR1 Approaches)	-----	3.0	9.3
(C2+B) N/S Taxiway (Indep. IFR1 Approaches)	-----	2.6	7.3
(D+C1+B) New Runway	-----	1.9	4.5

Note: (D+C1+B) New Runway, N/S Taxiway, All Aircraft Can Diverge

PDX ANNUAL DELAY COSTS (in millions of dollars) – GRAPH



Note: (D+C1+B) New Runway, N/S Taxiway, All Aircraft Can Diverge

EXHIBIT 2 – N/S TAXIWAY AND EXISTING DEPARTURE NOISE RESTRICTIONS (cont.)

PDX ANNUAL DELAY COSTS (in millions of dollars) – TABLE

(HOURS OF DELAY PER YEAR, MILLIONS OF YEAR 2000 DOLLARS)

IMPROVEMENT STUDIED	322,000 (1999) -- C O S T S --		484,000 (F1) -- C O S T S --		620,000 (F2) -- C O S T S --	
	HOURS	MILL \$	HOURS	MILL \$	HOURS	MILL \$
(0) CALIBRATION (Do-Nothing)	7,409	\$12.3	51,376	\$85.3	435,257	\$722.5
(C1) N/S Twy & Noise (Stag. IFR1 Approaches)	Not Simulated		46,668	\$77.5	366,558	\$608.5
(C2) N/S Twy & Noise (Indep. IFR1 Approaches)	Not Simulated		43,902	\$72.9	354,102	\$587.8
(A) All Turbos & Biz Jets Can Diverge	6,091	\$10.1	34,511	\$57.3	184,628	\$306.5
(B) All Aircraft Can Diverge	5,959	\$9.9	31,249	\$51.9	151,505	\$251.5
(C1+B) N/S Taxiway (Stag. IFR1 Approaches)	Not Simulated		23,857	\$39.6	96,179	\$159.7
(C2+B) N/S Taxiway (Indep. IFR1 Approaches)	Not Simulated		20,708	\$34.4	75,539	\$125.4
(D+C1+B) New Runway	Not Simulated		15,192	\$25.2	46,303	\$76.9

Notes:

- (C1+B) N/S Taxiway, All Aircraft Can Diverge, & Staggered Approaches in IFR1
- (C2+B) N/S Taxiway, All Aircraft Can Diverge, & Independent Approaches in IFR1
- (D+C1+B) New Runway, N/S Taxiway, All Aircraft Can Diverge,
& Staggered Approaches in IFR1 to Existing Parallel Runways
(3 Independent Arrival Streams in VMC)
(2 Independent Arrival Streams to Outboards in IFR1)

EXHIBIT 3 – EXTEND RUNWAY 10L/28R 1,500’ TO THE WEST

HOURS OF TAXI TIME SAVINGS PER YEAR, YEAR 2000 DOLLARS

IMPROVEMENT STUDIED	With 15 MPH Taxi --S A V I N G S--	
	HOURS	DOLLARS
10 International Heavy Departures Daily -- 1999 Demand	82	\$136,000
15 International Heavy Departures Daily -- Future 1	123	\$204,000
18 International Heavy Departures Daily -- Future 2	148	\$246,000
20 International Heavy Departures Daily	165	\$274,000
25 International Heavy Departures Daily	206	\$342,000
30 International Heavy Departures Daily	247	\$410,000
35 International Heavy Departures Daily	288	\$478,000
40 International Heavy Departures Daily	329	\$546,000

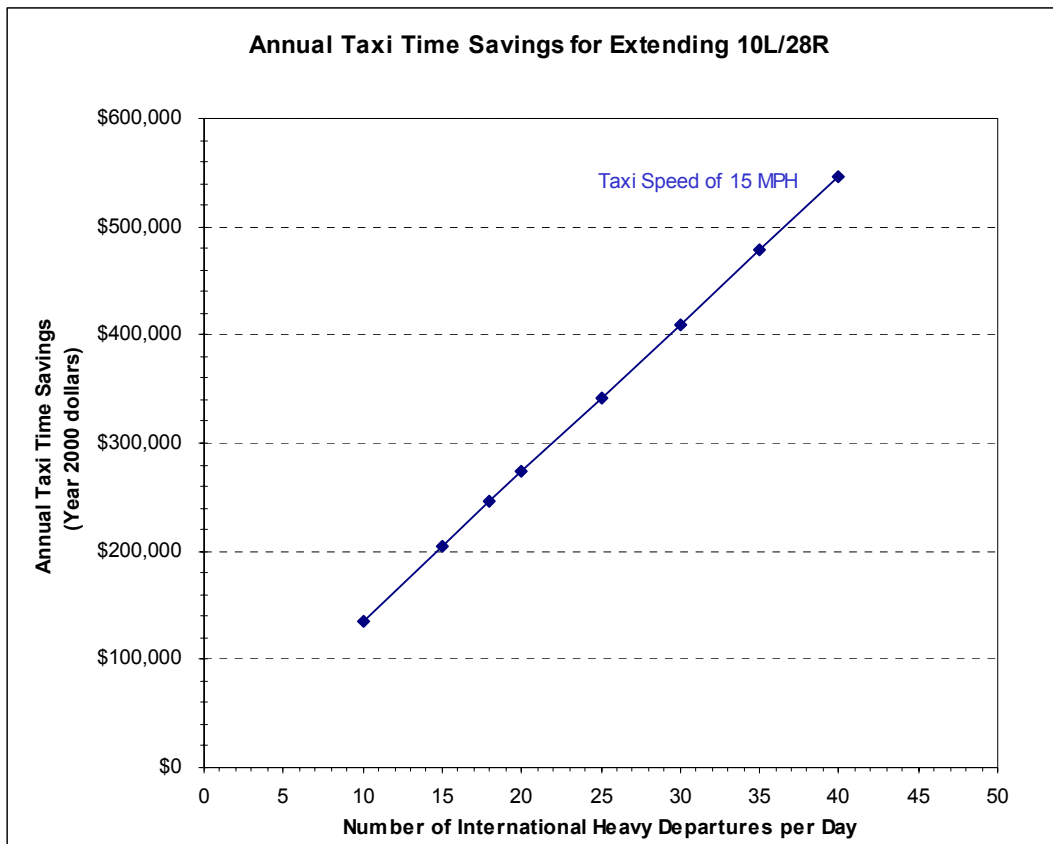
Note: 1999 Demand represents 322,000 annual ops.

Future 1 Demand represents 484,000 annual ops.

Future 2 Demand represents 620,000 annual ops.

Dollar savings are based on a direct operating cost of \$1,660 per hour for the PDX fleet.

The block hour cost of a Heavy could be at least double that cost, which would include all phases of flight.



Note: 15 MPH equals 13 knots.

EXHIBIT 4 – ADD EXIT A-1A TO RUNWAY 10L – 1,000 FEET WEST OF EXIT A-1

HOURS OF COMBINED TAXI and OCCUPANCY TIME SAVINGS PER YEAR, YEAR 2000 DOLLARS

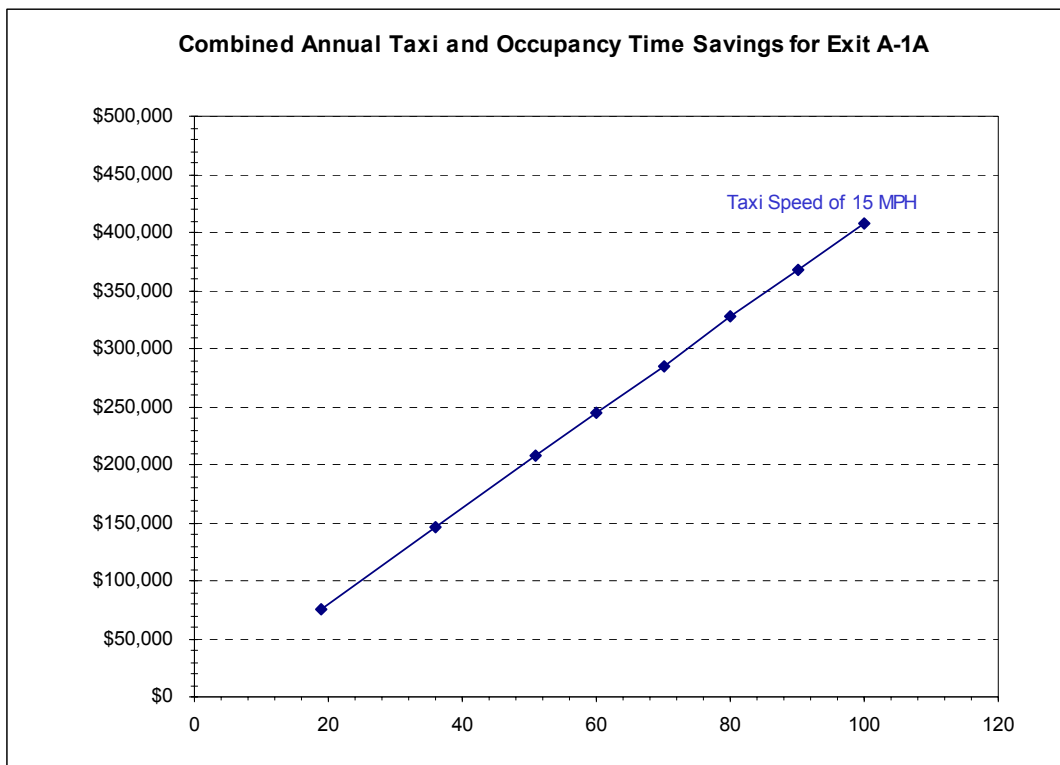
IMPROVEMENT STUDIED	With 15 MPH Taxi Combined Savings	
	HOURS	DOLLARS
19 Arrivals Daily Use A-1A -- 1999 Demand	46	\$76,000
36 Arrivals Daily Use A-1A -- Future 1	88	\$146,000
51 Arrivals Daily Use A-1A -- Future 2	125	\$208,000
60 Arrivals Daily Use A-1A	147	\$244,000
70 Arrivals Daily Use A-1A	171	\$284,000
80 Arrivals Daily Use A-1A	197	\$327,000
90 Arrivals Daily Use A-1A	221	\$367,000
100 Arrivals Daily Use A-1A	245	\$407,000

Note: 1999 Demand represents 322,000 annual ops.

Future 1 Demand represents 484,000 annual ops.

Future 2 Demand represents 620,000 annual ops.

Dollar savings are based on a direct operating cost of \$1,660 per hour for the PDX fleet.



Note: 15 MPH equals 13 knots.

EXHIBIT 4 – ADD EXIT A-1A TO RUNWAY 10L -- 1,000 FEET WEST OF EXIT A-1 (cont.)

**PDX TAXI TIME SAVINGS FOR ADDING EXIT A-1A
HOURS OF TAXI TIME SAVINGS PER YEAR, YEAR 2000 DOLLARS**

IMPROVEMENT STUDIED	With 15 MPH Taxi --S A V I N G S--	
	HOURS	DOLLARS
19 Arrivals Daily Use A-1A -- 1999 Demand	40	\$66,000
36 Arrivals Daily Use A-1A -- Future 1	76	\$126,000
51 Arrivals Daily Use A-1A -- Future 2	108	\$179,000
60 Arrivals Daily Use A-1A	127	\$211,000
70 Arrivals Daily Use A-1A	148	\$246,000
80 Arrivals Daily Use A-1A	170	\$282,000
90 Arrivals Daily Use A-1A	191	\$317,000
100 Arrivals Daily Use A-1A	212	\$352,000

Note: 15 MPH equals 13 knots

**PDX OCCUPANCY TIME SAVINGS FOR ADDING EXIT A-1A
HOURS OF OCCUPANCY TIME SAVINGS PER YEAR, YEAR 2000 DOLLARS**

IMPROVEMENT STUDIED	Occupancy Time --S A V I N G S--	
	HOURS	DOLLARS
19 Arrivals Daily Use A-1A -- 1999 Demand	6	\$10,000
36 Arrivals Daily Use A-1A -- Future 1	12	\$20,000
51 Arrivals Daily Use A-1A -- Future 2	17	\$28,000
60 Arrivals Daily Use A-1A	20	\$33,000
70 Arrivals Daily Use A-1A	23	\$38,000
80 Arrivals Daily Use A-1A	27	\$45,000
90 Arrivals Daily Use A-1A	30	\$50,000
100 Arrivals Daily Use A-1A	33	\$55,000

Note: 1999 Demand represents 322,000 annual ops.
 Future 1 Demand represents 484,000 annual ops.
 Future 2 Demand represents 620,000 annual ops.
 Dollar savings are based on a direct operating cost of \$1,660 per hour for the PDX fleet.

EXHIBIT 5 – ADD EXITS ON TAXIWAY C

ADD EXIT C-2 – EAST FLOW -- COMBINED TRAVEL AND OCCUPANCY TIME SAVINGS

	1999 demand – Annual Savings (322,000 annual ops)		Future 1 demand – Annual Savings (484,000 annual ops)	
	Hours	\$ per year	Hours	\$ per year
Taxi Savings	9	\$14,900	13	\$21,600
<u>ROT Savings</u>	<u>1</u>	<u>\$1,700</u>	<u>2</u>	<u>\$3,300</u>
Total Savings	10	\$16,600	15	\$24,900

Notes: 30% of the Small (Class 6) Box-Haulers at the S. W. Ramp will use exit C-2 in the East Flow.
 1999 demand using Exit C-2: 2 ops per day in the East Flow.
 Future 1 demand using Exit C-2: 3 ops per day in the East Flow.
 East Flow taxi savings of 1.6 minutes per op are based on 2,100 feet shorter taxi at 15 MPH.
 Each arrival saves 16 seconds of occupancy time in the East Flow.
 East Flow occurs 52.3% of the year.

ADD EXIT C-2 – WEST FLOW -- RUNWAY CROSSING TIME SAVINGS

	1999 demand – Annual Savings (322,000 annual ops)	Future 1 demand – Annual Savings (484,000 annual ops)
Number of Runway Crossings	2,748	3,358
Hours	23	28
Dollars	\$38,000	\$46,000

Notes: West Flow – 70 % Military, Heavy, and 757 cargo using C-2 instead of B-2:

- 70% of 1999 demand using Exit C-2: 18 ops per day in the West Flow.
- 70% of Future 1 demand using Exit C-2: 22 ops per day in the West Flow.

West Flow runway crossing savings of 0.5 minutes per op.
 West Flow occurs 47.7% of the year.
 15 MPH equals 13 knots.

EXHIBIT 5 – ADD EXITS ON TAXIWAY C (cont.)**ADD EXIT C-4 – COMBINED TRAVEL AND OCCUPANCY TIME SAVINGS**

	1999 demand – Annual Savings (322,000 annual ops)		Future 1 demand – Annual Savings (484,000 annual ops)	
	Hours	\$ per year	Hours	\$ per year
Taxi Savings	10	\$16,600	17	\$28,200
<u>ROT Savings</u>	<u>1</u>	<u>\$1,700</u>	<u>2</u>	<u>\$3,300</u>
Total Savings	11	\$18,300	19	\$31,500

Notes: 1999 demand using Exit C-4: 7 ops per day; 4 in the East Flow and 3 in the West Flow.
Future 1 demand using Exit C-4: 11 ops per day; 6 in the East Flow and 5 in the West Flow.
East Flow taxi savings of 0.4 minutes per op are based on 500 feet shorter taxi at 15 MPH.
West Flow taxi savings of 0.8 minutes per op are based on 1,000 feet shorter taxi at 15 MPH.
Each arrival saves 3 seconds of occupancy time in the East Flow and 6 seconds in the West Flow.
East Flow occurs 52.3% of the year.
West Flow occurs 47.7% of the year.
15 MPH equals 13 knots.

ADD EXIT C-5 – COMBINED TRAVEL AND OCCUPANCY TIME SAVINGS

	1999 demand – Annual Savings (322,000 annual ops)		Future 1 demand – Annual Savings (484,000 annual ops)	
	Hours	\$ per year	Hours	\$ per year
Taxi Savings	55	\$ 91,000	68	\$113,000
<u>ROT Savings</u>	<u>9</u>	<u>\$ 15,000</u>	<u>11</u>	<u>\$ 18,000</u>
Total Savings	64	\$106,000	79	\$131,000

Notes: There are no benefits in the West Flow for this exit.
1999 demand using Exit C-5: 18 ops per day – 11 cargo and 7 military.
Future 1 demand using Exit C-5: 22 ops per day – 14 cargo and 8 military.
East Flow taxi savings of 1.1 minutes per op are based on 1,500 feet shorter taxi at 15 MPH.
Each arrival saves 11 seconds of runway occupancy time.
East Flow occurs 52.3% of the year.
15 MPH equals 13 knots.

